Event Data

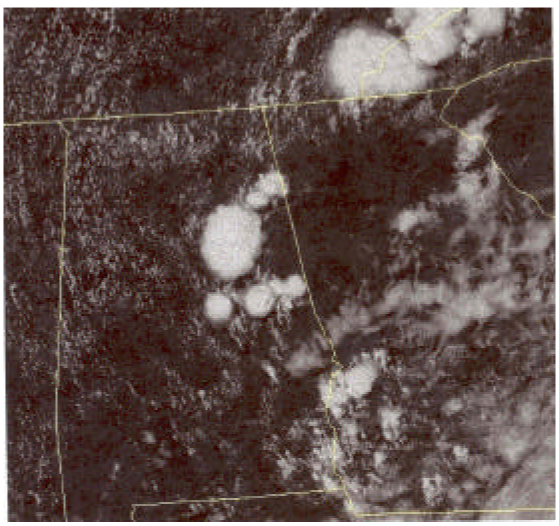
The following event case days are listed in chronological order. All cases occurred along intersecting boundaries with multiple storms present. Data was provided by National Weather Service partners (BMX, LZK, MEG and SHV). The following wet microburst event images acquired from the partners may be found within the event base.

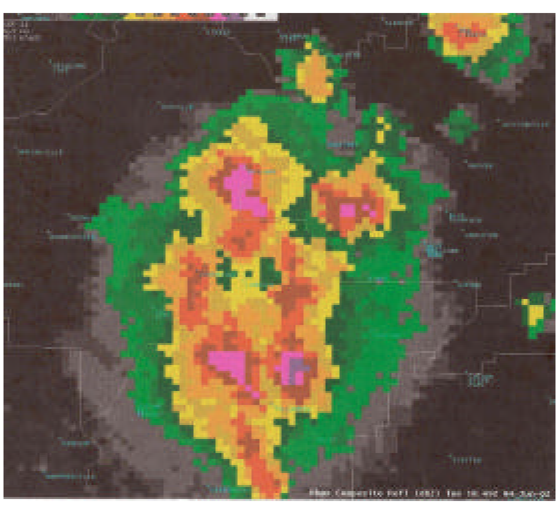
9 September 1997

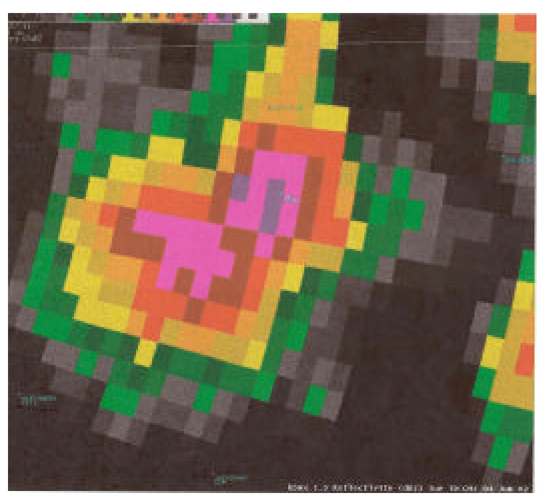
SHV – Three radar images containing base reflectivity and velocity.

4 June 2002

BMX – Four images containing visible satellite, base reflectivity, and velocity. Satellite and reflectivity show the multicellular nature of convection with multiple storms present. Velocity image shows convergence.







<u>23 June 2002</u>

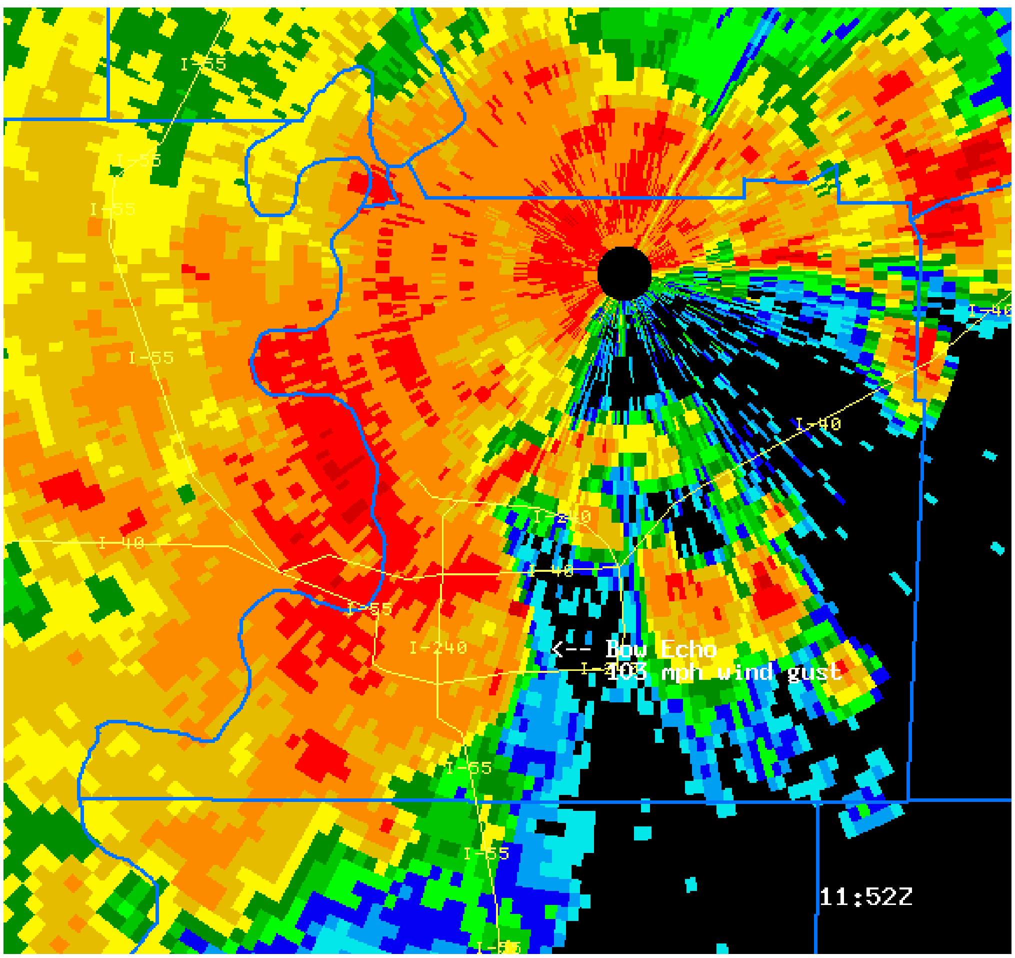
LZK – Two four panel images containing base reflectivity and velocity.

<u>23 July 2002</u>

LZK – Two four panel images containing base reflectivity and velocity.

<u>22 July 2003</u>

MEG – One image containing base reflectivity. Image shows bow echo entering Memphis, TN bringing winds over 100mph.

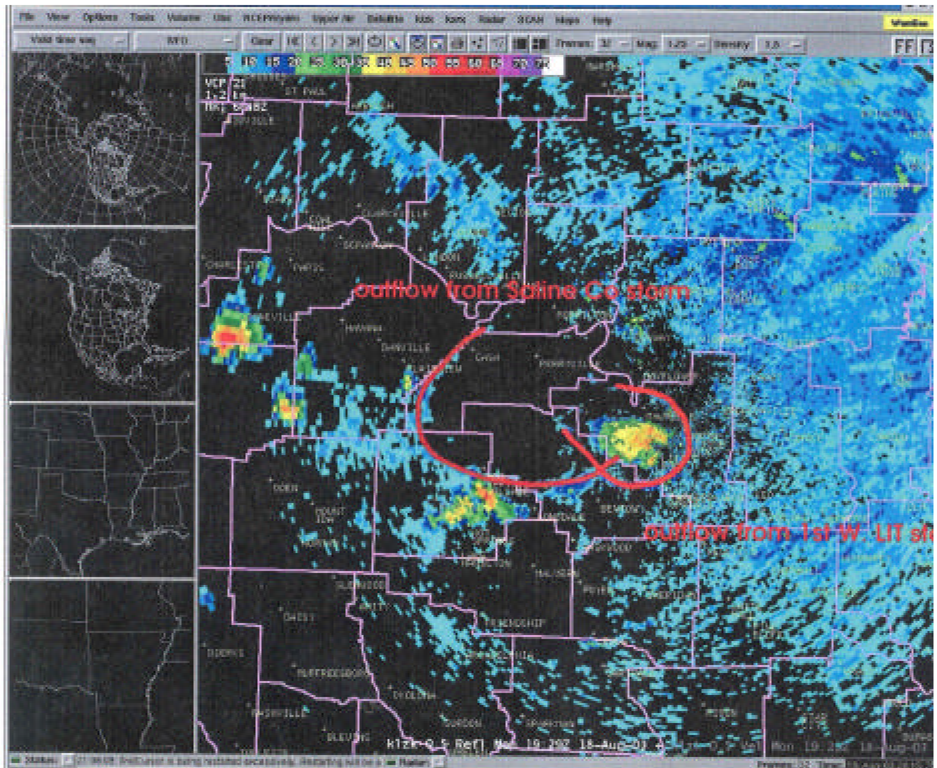


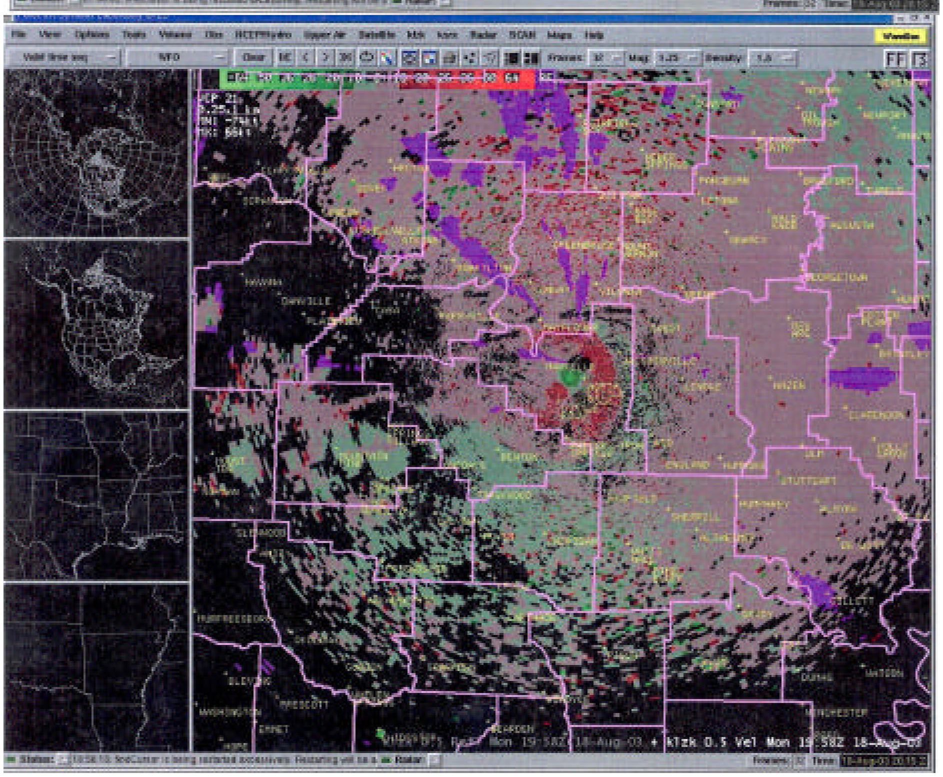
<u>4 August 2003</u>

MEG – Two images containing velocity.

<u>18 August 2003</u>

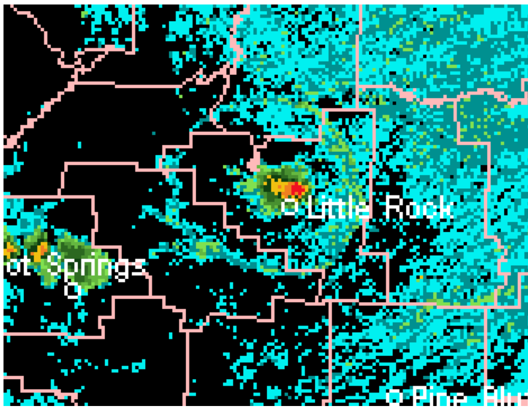
LZK – Two images containing base reflectivity and velocity. Images show microburst producing cell within close proximity to LZK radar site.





<u>18 August 2003</u>

ULM – Two images containing one base reflectivity (courtesy of weathertap.com) and one tower camera photo (courtesy of KATV-TV Little Rock, AR). Reflectivity image shows outflow boundary from microburst producing storm. Tower cam image shows a large precipitation shaft with rainfoot (view is to the northwest).

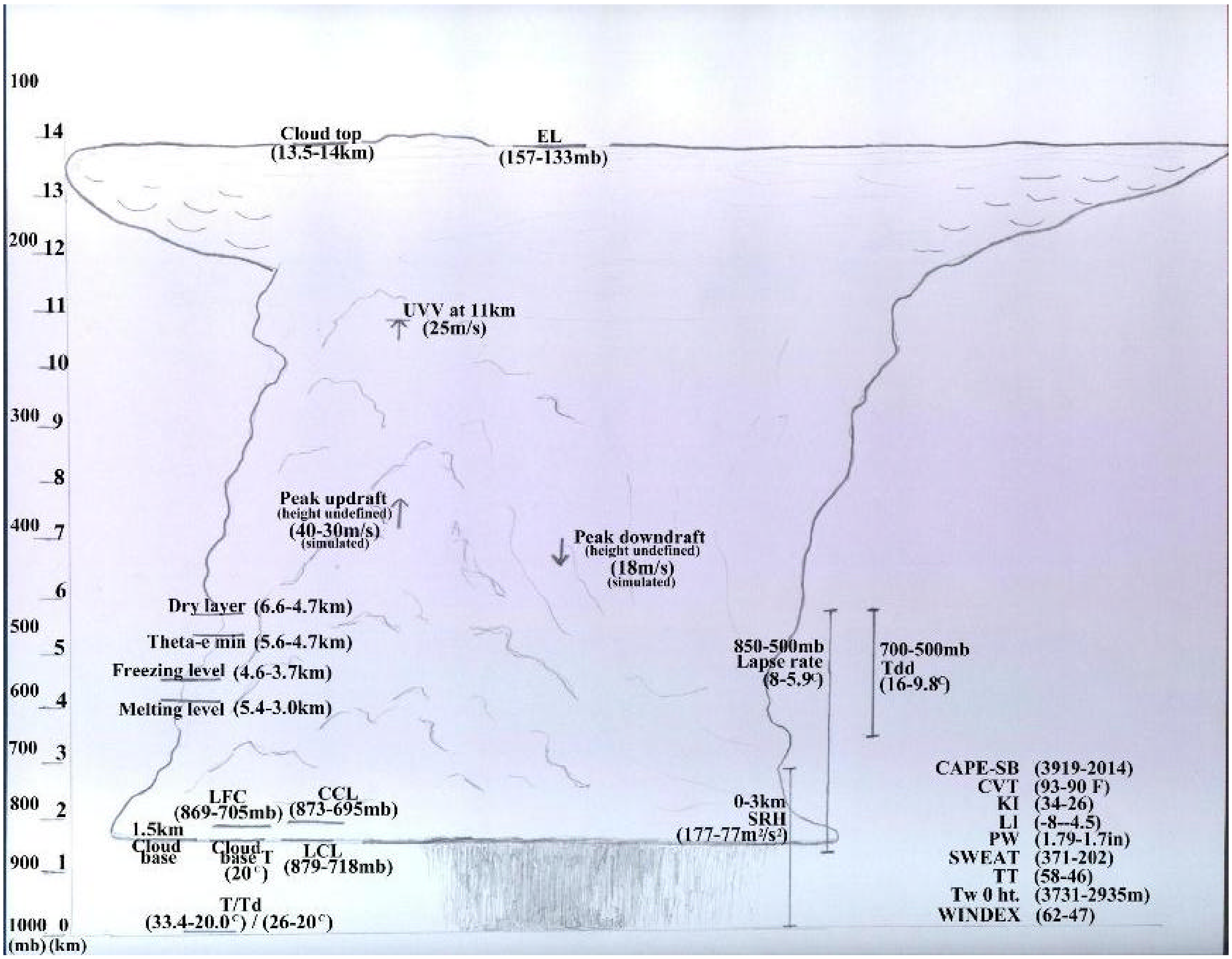


A publication (or report) of the University of Louisiana at Monroe pursuant to an Outreach Program Agreement with the University Corporation for Atmospheric Research and pursuant to National Oceanic and Atmospheric Administration Award No. NA17WD2383. <u>Preliminary Investigation of Observed Microburst Characteristics and Forecasting Methods</u>.

Further Documentation

Poster - 28th Annual Meeting of the National Weather Association – 20 October 2003

Conceptual Model



Radar Model

Note – The excel files containing *imagery_sum* and *parameter_base* are not printed in the packet as the large file size prohibited the inclusion of the files.

Preprint

WET MICROBURST – STUDENT TRAINING AND ROLE IN ON-LINE BIBLIOGRAPHY AND EVENT SELECTION

Paul J. Croft*, Patrick Pyle, and Scott Blair
University of Louisiana at Monroe, Monroe, Louisiana

* *Corresponding Author Address*: Dr. Paul J. Croft – Associate Professor of Meteorology, University of Louisiana at Monroe, Department of Geosciences, 700 University Drive, Monroe, LA 71201; email <croft@ulm.edu>.

1. INTRODUCTION

As part of a wet microburst study, a preliminary bibliographic base and reference data set for the Southern Region has been developed. Two undergraduate atmospheric science majors (second and third authors of this paper) collected, reviewed, organized, and summarized all of these materials. In the process, a variety of professional and skills development opportunities have been possible for them ranging from keyword selection used in searching of resource contents to the identification of reference and resource types available.

In addition, students necessarily had to consider the material from a scientific viewpoint, be prepared to discuss the materials with peers in the field, and formulate conceptual models and diagrams needed to organize the information into a coherent and operationally-oriented framework. This included visits to partnering NWS Forecast Offices involved in the project and the examination of specific events and radar imagery. Production of the end products also required them to develop their communication skills. There was great potential for personal and professional development as both students acted in their capacities as meteorologists. This demanded attention to details, succinctness, and specificity not typical of mid-level or senior undergraduate meteorology majors. The project also permitted them to gain experience working on funded research and thus to gain an appreciation of operational research and the skills necessary in graduate work.

2. PROJECT GOALS

Project goals for students were based on full immersion into the process of research from initial literature review and understanding to synthesis, analyzing relationships, interpretation of conflicting information, portrayal, physical understanding, and the development of conceptual models and their applications. Upon completion, the students were also afforded opportunity for professional growth through seminar presentations, preprint preparations, and poster/oral discussions.

As part of the process, the students accessed a variety of sources (web-based, professional literature, office documents, and others). They were often left to "think-on-their-own" and to offer alternative solutions or approaches to questions arising during their investigations. In some cases they were able to take advantage of situations or information that presented itself during the project. These pragmatic opportunities were an important component in the students' search for answers as to the development, morphology, and prediction of wet microbursts.

3. ACTIVITIES & OUTCOMES

The students began project work in early summer of 2003 and continued into the fall semester. Beginning with collection of literature and resources on the microburst phenomenon, they accessed websites and libraries. Using keywords (e.g., downburst, microburst) and organizing resources by type challenged them to develop a manageable system for archival and manipulation of the information base.

Websites offered a plethora of possibilities and included information on microburst events, descriptions, pictures, and general education or training materials. Decision-making was essential when considering that sources ranged from pseudo-scientific (or not at all) to informational, visual, or theoretical. Understanding how best to separate and represent these for the public or the professional community was a learning process. Information from scientific journals and other periodicals provided a basis for the students to relate their coursework to operational applications and forced them to understand extensions of their basic knowledge to new situations. The operational aspects were of particular interest and a driving force for the project in order to improve real-time recognition and prediction of wet microbursts. The contrasts between the realities of the atmosphere, forecast models, theory-based principles of atmospheric behavior, and how these may complement one another provided important lessons.

For example, a goal of the overall project was the development of an initial conceptual model of the "microburst family" to improve operational recognition and prediction. The model would provide information on the characteristics of members of the overall family of microbursts. This required the collection of a broad set of population characteristics and parameters used in microburst observation, analysis, and prediction. In other words, the ability to identify from which "clan" a particular form of wet microburst originates within is useful to forecasters. This is comparable to the "sea breeze family" (or spectrum) when predicting the nature of interactions and convective activity for the day. Visits to some of the partnering NWS Forecast Offices (JAN, LIT, MEM, SHV) were also of significance as it gave them a clear operational view and approach to the microburst issue and perspective with which to consider the purely theoretical applications and model simulations found in the literature. In addition, they were able to receive some real-time experience in radar interpretation and reanalysis by working with NWS staff. For those offices not visited, they relied on phone calls and/or emails for scientific exchange and also dealt with issues of file transfer and portability.

4. RESULTS

As part of the overall project, the completion and dissemination of bibliographic and event data sets were intended to provide a summary of what is known and unknown about wet microbursts, describe the basic microburst family and its associated parameters, identify the most appropriate operational tools for prediction and detection, and begin to discern the storm scale cues (from radar) that can increase lead-time and provide evidence of the forces leading to isolated versus widespread microbursts.
The summary information and associated documentation is composed of several reports and arranged/organized according to the following categories: web, journal, parameter, imagery, image summary, checklist, and model development. The web portion was developed to be a part of the bibliographic base to identify research and educational resources on-line. Each of these was summarized from an operational forecast perspective and according to natural groupings (e.g., AMS, Educational, and Vendor). This allows a user to quickly access a desired focus and easily interpret information.
The journal base contains a listing of peer reviewed articles that pertain to many members of the microburst family (e.g., bow-echo, isolated, cell interactions, widespread) and their characteristics. This information is primarily associated with physical understanding of the ingredients and processes at work in microburst production and thus is of educational and research value. Together, they provide a basis for development of an empirical conceptual model of the microburst family.

Related to conceptual model development are the parameter and imagery bases, derived from the journal and web resources, which provide the morphological characteristics and other relevant information for the depiction of the microburst family. The parameter base provided a physical understanding of the microburst process and was organized in a spreadsheet format for comparison and reference. Three distinct areas of focus were identified and include thermodynamic, kinematic, and radar/miscellaneous.
The imagery base provided the ability to depict a variety of complex parameters, and their associations, in an operational framework that could be readily applied in a forecast or nowcast situation. The imagery base consists of thermodynamic profiles, radar and satellite imagery, surface and upper air maps, and time series or cross-section plots of thermodynamic and/or kinematic variables. This resource also provides an operational forecaster with a clear depiction of the tools to use that are available, and other tools that could be made available.

A composite checklist was also possible given input from the NWS Partners in combination with the aforementioned resource bases. The composite listing is intended to provide guidance in the discrimination of severe versus non-severe cases in a weak shear environment and to allow real-time assessment of parameters for a given day's forecast. Of the parameters included, selection was made of those that were most commonly cited or used by the NWS Partners to provide some consistency when anticipating microburst events. They also provided an opportunity for direct comparison and contrast between operational practice and theoretical approaches.

When combined, the above resource bases provide for the development of an empirical (and somewhat theoretical) conceptual model. In this work, two models were developed – one for the storm structure within its environment, and another according to radar information to provide a model of storm structure and characteristics during and before the formation of the microburst event. In essence, these models provide a physical and dynamic model (over time, or stage of development) that may assist the forecast process in identifying the chance of microburst events, their coverage, and help to distinguish between days with events versus those without – particularly in those situations in which no obvious differences exist in the synoptic or mesoscale settings from day-to-day.

5. COMMENTS

During the course of the project the students developed an improved understanding of both the phenomenon of interest and the nature of the research process. In particular, the assembly of diverse data and information resources allowed them to put the puzzle together using an operational perspective.

While the driving force or motivation for the project was to gain a better understanding in order to develop a conceptual model, the motivation for the students to pursue the project varied. The research opportunity provided a chance to use and develop skills in their field while also experiencing first-hand the nature of research, its obstacles, and the rewards. For each student the project provided a time to experiment with research and other interests and involved their immersion into the field's literature and other resources. It gave them reason to work with professionals in the discipline and an appreciation for the planning and communications necessary to achieve project goals.

The relationship between project work and the students' degree work included tie-in of their course materials with scientific study. The collection and organization of materials, and their proper display or representation, were critical skills helpful for career preparation.

ACKNOWLEDGEMENTS

This paper is funded under a cooperative agreement between the National Oceanic and Atmospheric Administration (NOAA) and the University Corporation for Atmospheric Research (UCAR). The views expressed herein are those of the author(s) and do not necessarily reflect the views of NOAA, its sub-agencies, or UCAR.

A publication (or report) of the University of Louisiana at Monroe pursuant to an Outreach Program Agreement with the University Corporation for Atmospheric Research and pursuant to National Oceanic and Atmospheric Administration Award No. NA17WD2383.

We are grateful for our NWS and other Partners including: Chris Buonanno, Jeff Craven, Ken Falk, Alan Gerard, Lee Harrison, Jonathan Howell, Scott McNeil, Jeffrey Medlin, Kevin Pence, and Russ Schneider (SPC).

This paper was also supported by the staff and facilities available at the University of Louisiana at Monroe (ULM). The assistance of the staff and faculty, as well as the use of resources at ULM, was greatly appreciated. Our special thanks to the ULM Atmospheric Science Program within the Department of Geosciences.

WET MICROBURST – BIBLIOGRAPHY, ANNOTATION, DATA

Paul J. Croft[·] and Alan E. Gerard
University of Louisiana at Monroe, Monroe, Louisiana
National Weather Service, Jackson, Mississippi

P4.11

[·] *Corresponding Author Address*: Dr. Paul J. Croft – Associate Professor of Meteorology, University of Louisiana at Monroe, Department of Geosciences, 700 University Drive, Monroe, LA 71201; email <croft@ulm.edu>.

1) INTRODUCTION

Despite their prevalence, and their ability to cause damage on par with other types of severe weather, microbursts in the United States have received little dedicated study or attention. Microburst occurrences are often reported as thunderstorm wind damage – and thunderstorm wind damage reports to the Storm Prediction Center now total nearly 10,000 per year.

Although the general nature of microburst occurrence and properties may be predicted through dynamic reasoning, the particular characteristics of their occurrence, and their metrics, is not well-known or predicted. In fact the conceptual models used in explaining their occurrence and behavior are unreliable. This is partly due to microphysical contributions and a lack of complete understanding of the thermodynamic environment that leads to their occurrence rather than tornadoes, straight line winds, or large hail.

In an effort to ameliorate this lack of knowledge and forecast ability, an examination of observed "microburst family" characteristics was prepared based on available resources in the meteorology community. These include web-based information and products, literature, and real-time observational data from events. The events were provided to the University of Louisiana at Monroe Atmospheric Science Program by NWS Partners (BMX, JAN, LIT, MEM, MOB, SHV) and SPC. The Project Director and two undergraduate meteorology majors (Patrick C. Pyle and Scott F. Blair) were responsible for the development of the collected resources.

The intent is to provide better qualitative and quantitative information on the phenomenon and to determine appropriate tools to aid in predicting the occurrence of microburst events. The objectives of the study were to (1) Determine the base characteristics and properties of observed microbursts; (2) Develop a prototype conceptual model; (3) Provide an annotated bibliographic database for operations, research, and education; and (4) Disseminate and coordinate informational exchange within the scientific community.

Qualitative and quantitative information were of interest as they are essential in an operational environment tasked with the prediction of pulse severe weather under weak shear conditions (i.e., duration, intensity, scale/size, and storm scale features). As such the outcomes must include: the observed characteristics of the family of microbursts that occur; forecast checklists; and a subset of occurrences for direct examination.

The project has seen the preliminary development of both a bibliographic and event database to aid in operational microburst forecasting and detection. The body of literature and the event data have assisted in establishing the population characteristics of Southern Region wet microbursts within the parent distribution (or family) of wet microbursts. Such characteristics include observed and theoretical attributes of the microbursts, their physical basis, and the physical processes preceding their occurrence. These are expected to provide a basis for improved understanding, prediction, and detection of wet microbursts operationally.

2. DEVELOPMENT

The bibliographic database was constructed based upon existing literature through exhaustive searches on-line including: AMS journals archive, geo-astrophysical abstracts (vendor), and various electronic resources. The searches were based primarily upon the following keywords (or variants thereof) – microburst, downburst, downdraft.

From these searches, a multiple file system was developed to contain select information for annotated listings. The intent was to provide a wide ranging collection of resources and summary information that would allow different user communities to access those aspects of the
microburst literature of most interest to them and to allow for cross-referencing of the materials. Each resource was reviewed for inclusion or removal and was used to not only construct a bibliographic base, but also to provide information for the development of a scientific base to depict the characteristics of the microburst population (or family).

Within this file system, NWS partners provided forecast checklists used operationally, local studies, and specific event information (including radar analyses). This information was incorporated with the parameter spreadsheets and integrated with various simulations and modeling efforts as gleaned from the literature. In this manner, a conceptual framework and working model of microburst initiation, development, and occurrence have been developed from an operational perspective. In addition, differentiation between isolated and widespread events on a given day, were considered.

The event database is comprised of synoptic and mesoscale settings in the pre-storm environment, appropriate thermodynamic and kinematic analyses, and operational forecast tools used, and storm scale features as derived from WSR-88D investigations (as available from NWS partners). These provide the broader conditions conducive to the occurrence of microbursts as well as the actual morphology of the microburst family. These also provide bases for the conceptual model that illustrates the pre-storm environment, the initiation and development of pulse severe cells (or lines), and their characteristics as observed in operations by radar.

3) OUTCOMES

The empirically-based conceptual model was generated by synthesis of the bibliographic and event bases and coordination with the NWS partners. This resulted in an empirical model of the wet microburst family and an empirical model based on event radar imagery. In combination, these are intended to assist operational forecasters in the interpretation of risk and the nature of events (widespread versus isolated).

The complete set of resources are contained in a hardcopy version (including all journal articles referenced) available for review at the University of Louisiana at Monroe. Electronic copies (excluding the journals but not their reference citations) will be made available to the NWS partners. It is anticipated that a partner, or another interest, will host an electronic version on-line to enhance distribution and accessibility to the broader community.

4) ACKNOWLEDGEMENTS

This paper is funded under a cooperative agreement between the National Oceanic and Atmospheric Administration (NOAA) and the University Corporation for Atmospheric Research (UCAR). The views expressed herein are those of the author(s) and do not necessarily reflect the views of NOAA, its sub-agencies, or UCAR.

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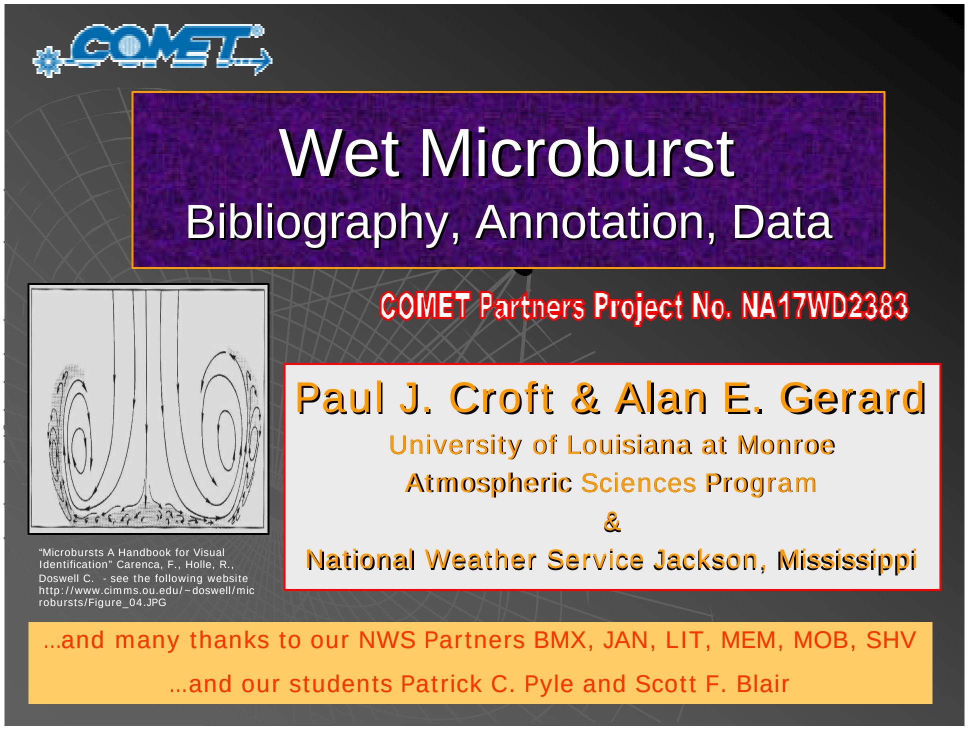
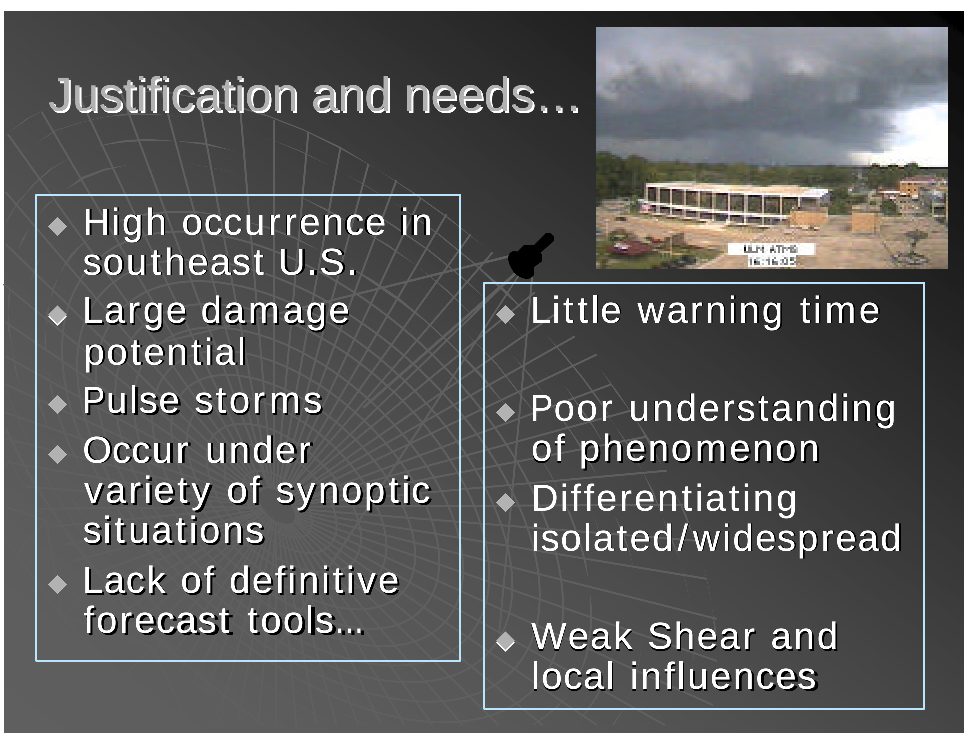
NWA 28th Annual Meeting Presentation





The Approach…

Operations & events are not theory

Reality

Variation of initial conditions & results

Establish what is known/unknown

- What is available, what works and why
- What is operationally oriented
- What do theory and modeling tell us
- What does reality show us (radar)

Establish the microburst family

- Wet microbursts only as 'clan' of family
- Allows for different initiation mechanisms or settings

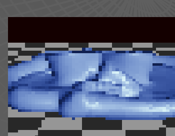
Components…

Bibliographic Basis

Literature, web-based, technical papers, operational methods, theory

Event/Operational Basis

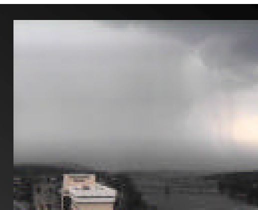
Microburst variations observed, checklists, local studies, radar



Why? – provide information to establish conceptual models and to help forecast process…

http://archive.ncsa.uiuc.edu/SDG/DigitalGallery/MBURST.html

Bibliographic Base



- Web-based materials, 155 sites
  - Keyword search
  - Subset

Comprehensive

- Journals and related publications, 34 papers
  - Keyword search
  - Cross-referencing

Exhaustive

- Development of Parameter Base
  - Papers, NWS Partners, Modeling, and other sources

Operational

- Development of Imagery Base
  - Papers and operational basis (consideration of simulations)

Operational orientation of tools & knowledge of wet microbursts to improve forecasting & warning lead-time

...but it must be Practical

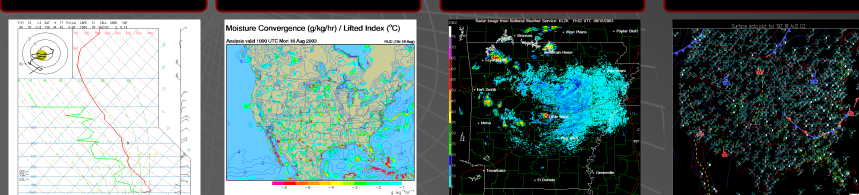
Parameter & Imagery Bases

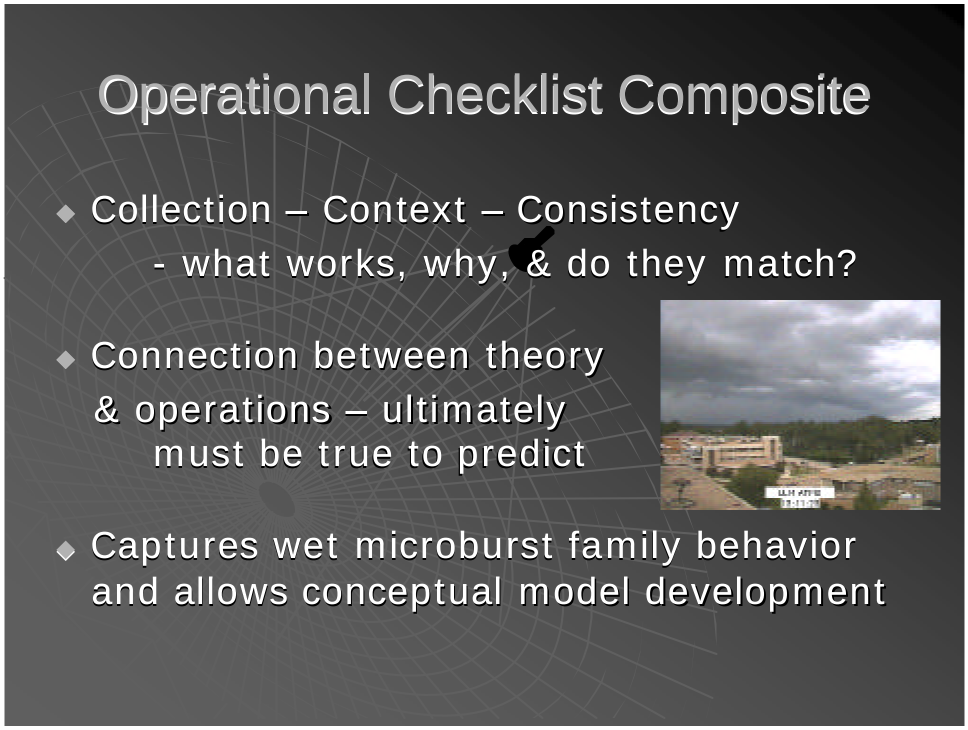
Event Day?

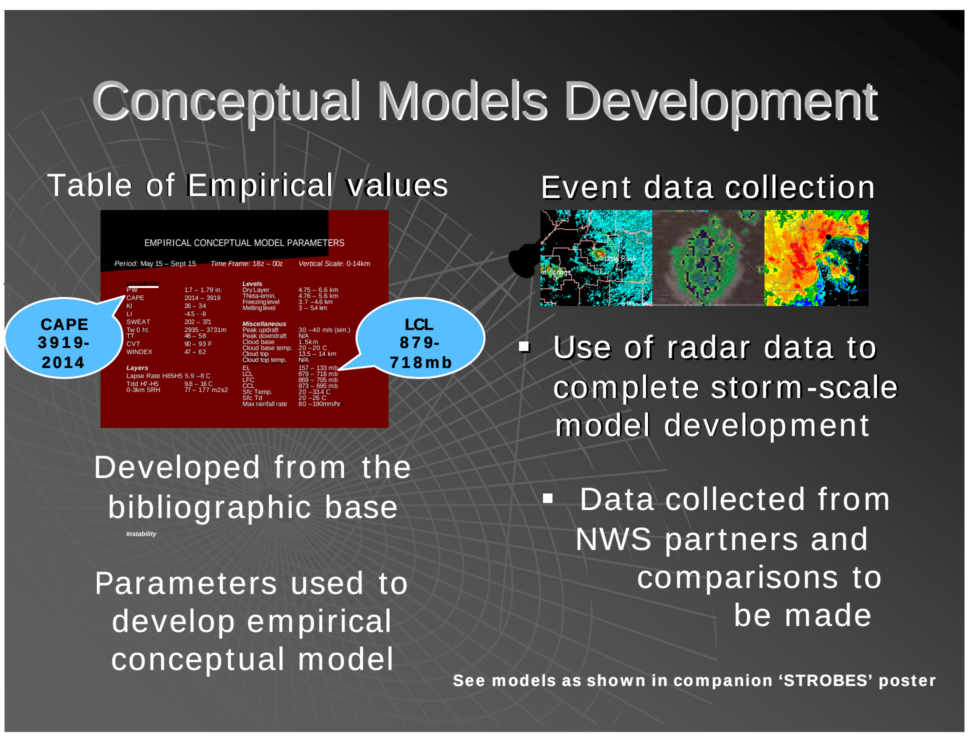
Non-Event Day?

Multiple?

Isolated?




Operational Checklist Composite
Collection – Context – Consistency
- what works, why, & do they match?
Connection between theory
& operations – ultimately
must be true to predict
Captures wet microburst family behavior
and allows conceptual model development


Conceptual Models Development
Table of Empirical values
EMPIRICAL CONCEPTUAL MODEL PARAMETERS
CAPE 3919-2014
LCL 879-718mb
Developed from the bibliographic base
Parameters used to develop empirical conceptual model
Event data collection
Use of radar data to complete storm-scale model development
Data collected from NWS partners and comparisons to be made
See models as shown in companion 'STROBES' poster

Application and Uses…

Bottom-line is…

- Documentation of resources and knowledge concerning wet microbursts (dynamic, physical, thermodynamic)
- Conceptualization and synthesis of events and variations into the 'family' of occurrences (sea-breeze, supercell)
- Summary of operational and theoretical tools that assist in daily forecasting as well as cell monitoring for characteristics associated with those 'more likely to produce' microbursts
- Advanced understanding, practical applications for operations, and improved warning time for the future

Availability of materials…

University of Louisiana at Monroe
- Mail, cd-rom, website plans

Acknowledgements

- COMET Program
- NWS Partners
- Storm Prediction Center
- ULM, Department of Geosciences

THANK YOU!

ULM Department of Geosciences Seminar

Wet Microburst:

Preliminary Investigation of Observed Microburst Characteristics and Forecasting Methods

Presenters:
Patrick C. Pyle
Scott F. Blair
Advisor:
Paul J. Croft

A publication (or report) of the University of Louisiana at Monroe pursuant to an Outreach Program Agreement with the University Corporation for Atmospheric Research and pursuant to National Oceanic and Atmospheric Administration Award No. NA17WD2383. Preliminary Investigation of Observed Microburst Characteristics and Forecasting Methods

What is a microburst?

A microburst is a severe downdraft from a thunderstorm.

It is confined to a small area, less than 4km (2.5 miles) in diameter from the initial point of downdraft impact.

The average microburst lasts for ten minutes.

Photo Credit:
http://www.targetarea.net

Microburst Types - Wet

Wet Microburst – A downdraft accompanied by heavy precipitation and severe winds at the surface.

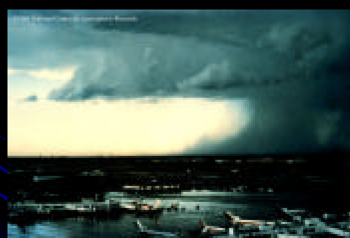


Photo Credits:
http://www.cimms.ou.edu/~doswell/microbursts
http://www.katv.com

Microburst Types – Dry

Dry Microburst – A downdraft accompanied by little to no precipitation along with severe winds at the surface.

Photo Credit:
http://www.cimms.ou.edu/~doswell/microbursts

Microburst Problem ?

- Short life time.
- Warning criteria difficult.
- Size and impact.
- Event days versus non-event days.

Photo Credit:
ULM Atmospheric Science Program

Solution ?

- Determine what is known / unknown.
- Operational identification of events.
- Operational methods to predict.
- Convergence theory / observations.
- Conceptual integration and modeling.

Photo Credit:
ULM Atmospheric Science Program

Wet Microburst Criteria

Period of Occurrence for Gulf

Period of Occurrence for Gulf States Region

- May 15 – September 15

Weak Shear Environment

- 20 knots or less

Event Data Collection

- All data from "true" microburst events
- Isolate storm scale features / characteristics

Photo Credit:
http://www.targetarea.net

Bibliographic Base

- Web Base
- Journal Base
- Parameter Base
- Imagery Base
- Operational

Bibliographic Base

Web Base

Developed from 155 microburst related web sites

Compiled Information

- Acquired through keyword search "microburst"
- Summary of each web site categorized for easy navigation in operational use (e.g., AMS, Educational, Newspaper, NOAA)

Journal Base

Developed from 34 microburst related journal articles from 1984 to 2002 (e.g., BAMS, WAF, JAM, MWR)

Compiled Information

- Summary for each article for easy navigation
- Parameters (instability, storm features)
- Imagery (radar, profiles)

Parameter Base

Parameters were collected by hand and organized onto an Excel spreadsheet. Parameters were gathered from the journal base and National Weather Service (NWS) partners.

Parameter Base

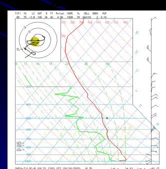
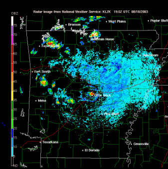
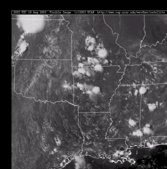
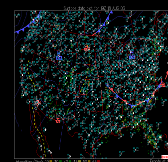
Thermodynamics	Kinematics	Radar / Misc.
71 Parameters	44 Parameters	27 Parameters
SBCAPE	0-6km Shear	Reflectivity
LI	0-3km SRH	VIL
LCL	Convergence	Echo Top
LFC	Peak Updraft	Cell Diameter
Surface T/Td	BRN	Max Core Height

Imagery

Imagery was collected from the journal base and summarized.

Imagery

Thermodynamics	Kinematics	Radar/Misc.	Standard Analyses
Skew-T	Time Series	Reflectivity	Surface Maps
Time Series	Hodograph (shear)	Satellite	Upper Air

Operational Microburst Checklist

Five checklists were acquired from the NWS Offices of Jackson, Shreveport, Birmingham, Mobile, and New Orleans.

A composite checklist was created to define the most frequently used parameters to help operational forecasters improve microburst forecasting.

Composite Checklist

Thermodynamics	*Kinematics*
SBCAPE	0-6km Weak Shear
H85-H5 Lapse Rate	
Precipitable Water	
Lifted Index	

Empirical Conceptual Model Development

- Model contains all microburst family
- Data was collected from the parameter base
- A number of parameters were omitted from the model due to the inability to acquire them in an operational setting
- Each parameter used was averaged and ranged

Empirical Conceptual Model Results

Period: May 15 – September 15 *Time Frame:* 18z-00z Vertical Scale: 0-14km

Instability

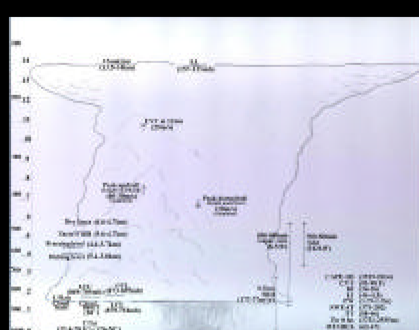
PW	1.7 – 1.79in
SBCAPE	2014 – 3919
KI	26 – 34
LI	-4.5 - -8
SWEAT	202 – 371
CVT	90 – 93F

Layers

Lapse Rate H85-H5	5.9 – 8 C
Tdd H7 – H5	9.8 – 16 C
0-3km SRH	77 – 177 m2s-2

Levels

Dry Layer	4.75 – 6.6 km
Theat-e min.	4.76 – 5.6 km



Wet Microburst Family

- Established a bibliography base for wet microburst activity.
- Created an event base to aid operational use and model development.
- Assess theoretical vs. operational knowledge and prediction.
- Isolate operational features and storm scale characteristics for improved forecasting.

Summary

- Useful to operational forecasting by providing a comprehensive resource for microburst material
- Applications range from operational, educational, and professional usage
- Data acquired will possibly open the door to new research theories related to microburst structure and evolution

Conclusion

The bibliographic base contains journal articles and website that provides data in the form of imagery and parameters. The event base provides a collection of radar data from microburst event days. The conclusion of the investigation was the development of the conceptual models that summarized all the data acquired.

Dissemination Possibilities

- CD-ROM of hard copy to each NWS partners
- Hard copy of files / paper will be available at the Southern Region Headquarters and ULM Atmospheric Science Program
- Poster or oral presentations at the American Meteorological Society and the National Weather Association annual conferences
- Final version of data will be hosted by a designated website

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